



DECLARATION

I, Yutaka Horii, c/o Fukami Patent Office, Nakanoshima Central Tower, 22nd Floor, 2-7, Nakanoshima 2-chome, Kita-ku, Osaka-shi, Osaka, Japan, declare:

that I know well both the Japanese and English languages;
that to the best of my knowledge and belief the English translation attached hereto is a true and correct translation of Japanese Patent Application No. 2000-035072, filed on February 14, 2000;

that all statements made of my own knowledge are true;
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[Document Name] Specification

[Title of the Invention] Cable Modem Tuner

[Scope of Claims for Patent]

[Claim 1] A cable modem tuner, comprising:

a tuner portion taking and amplifying a signal corresponding to a reception channel from input signals, and converting to an intermediate frequency signal of a first frequency band; and

a down converter portion receiving the intermediate frequency signal of said first frequency band, and selectively outputting an intermediate frequency signal of said first frequency band or a second frequency band lower than said first frequency band; wherein

said down converter portion includes

a local oscillation circuit generating an oscillation signal corresponding to said second frequency band in a first mode in which the intermediate frequency signal of said second frequency band is output, and stopping generation of said oscillation signal in a second mode in which the intermediate frequency signal of said first frequency band is output,

a mixer circuit for mixing the intermediate frequency signals of said first frequency band input to said down converter portion with an output of said local oscillation circuit, and

a filter circuit receiving an output signal from said mixer circuit and passing a signal of a frequency corresponding to a set cut off frequency.

[Claim 2] The cable modem tuner according to claim 1, wherein

said tuner portion includes a first AGC portion for adjusting amplitude of a signal corresponding to said reception channel to a prescribed level,

said cable modem tuner further comprising

a second AGC portion arranged between said tuner portion and said down converter portion, for adjusting amplitude of the intermediate frequency signal of said

first frequency band to a prescribed level.

[Claim3] The cable modem tuner according to claim 2, wherein total gain attained by said first and second AGC portion is at least 55dB.

[Claim 4] The cable modem tuner according to claim 1, wherein said tuner portion and said down converter portion output signals of non-parallel type, said cable modem tuner further comprising
a signal converting circuit receiving an output of said down converter portion and converting it to a parallel type signal.

[Claim 5] The cable modem tuner according to claim 1, wherein said mixer circuit amplifies the intermediate frequency signal of said first frequency band in said second mode.

[Claim 6] The cable modem tuner according to claim 5, wherein
said local oscillation circuit includes
an oscillation element oscillating at said second frequency band,
a first bipolar transistor receiving at an input electrode an output of said oscillation element,
a first bias resistance coupled between the input electrode of said first transistor and a first voltage node, and
a second bias resistance connected between one of output electrodes of said first bipolar transistor and the first voltage node; and
said mixer circuit includes
a second bipolar transistor receiving at an input electrode an output of said oscillation element and the intermediate frequency signal of said first frequency band,
a third bias resistance coupled between input electrodes of said first and second bipolar transistors, and
a fourth bias resistance coupled between the input electrode of said second bipolar transistor and a second voltage node supplying a voltage higher than said first voltage node.

[Claim 7] The cable modem tuner according to claim 6, wherein said local oscillation circuit further includes a switch element of which on/off is instructed externally, connected parallel to said oscillation element, said switch element turning on/off in said first and second modes, respectively.

[Claim 8] The cable modem tuner according to claim 6, wherein said filter circuit and said second bias resistance are mounted on one surface of a printed board, and

 said down converter portion except for said second bias resistance is mounted on the other surface of the printed board.

[Claim 9] The cable modem tuner according to claim 1, wherein said cut off frequency is set such that the signal of said second frequency band is passed and the signal of said first frequency band is attenuated in said first mode, and that the signals of said first and second frequency bands are passed in said second mode.

[Claim 10] The cable modem tuner according to claim 9, wherein said filter circuit has
 an inductance element passing an output signal of said mixer circuit,
 a first capacitance element coupled between said induction element and the ground node,

 a second capacitance element coupled in parallel with said induction element, and

 a switch element provided parallel to said second capacitance element and of which on/off is instructed externally,

 said switch element being turned off/on in said first and second modes, respectively.

[Claim 11] The cable modem tuner according to claim 1, further comprising:
 an intermediate frequency AGC portion positioned between said tuner portion and said down converter portion adjusting amplitude of the intermediate frequency signal of said first frequency band to a prescribed range; and

a signal converting circuit receiving an output of said down converter portion and converting to a parallel type signal; wherein

said cut off frequency is set such that the signal of said second frequency band is passed and the signal of said first frequency band is attenuated in said first mode, and that the signals of said first and second frequency bands are passed in said second mode.

[Claim 12] The cable modem tuner according to claim 11, wherein

said tuner portion, said intermediate frequency AGC portion, said down converter portion and said signal converting circuit are contained in one box.

[Detailed Description of the Invention]

[0001]

[Technical Field to Which the Invention Belongs]

The present invention relates to a cable modem tuner. More specifically, the present invention relates to a cable modem tuner suitable for outputting an intermediate frequency signal to a QAM demodulating circuit.

[0002]

[Prior Art]

In a cable television system (hereinafter referred to as CATV), introduction of HFC (Hybrid Fiber/Coax) has been in progress, in which a coaxial cable is kept as a subscriber's drop wire and the main network is implemented by optical fibers. This system attempts to provide broadband data communication service of several Mbits/sec at home. Utilizing this system, it is possible to realize high-speed data line having the transmission rate of 30 Mbits/sec with the bandwidth of 6MHz using 64 QAM (Quadrature Amplitude Modulation), which may not be called the state of the art any more. The cable modem is used in this system, and realizes high-speed data communication of 4 Mbits/sec to 27 Mbits/sec, utilizing an unused channel of cable television. The cable modem tuner is used for a cable modem in such a cable television system, and after the received CATV signal is subjected to frequency conversion, it serves to take out the signal as an intermediate frequency signal.

[0003]

Fig. 4 is a block diagram representing a configuration of a conventional cable modem tuner 200

[0004].

As for the CATV signals, an up signal transmitted to a station has the frequency of 5MHz to 42MHz, and a down signal transmitted from the station to the cable modem tuner has the frequency of 54MHz to 860MHz, and transmitted to a cable network through an input terminal 202 of the tuner. The up signal transmitted from the cable modem is received by a data receiver of the CATV station (system operator), and enters a computer of a center.

[0005]

Referring to Fig. 4, the cable modem tuner 200 includes a cable television signal input terminal 202 receiving the cable television signal as an input, a data terminal 204 receiving a data signal from a QPSK transmitter as an input, and an upstream circuit 220 provided between data terminal 204 and cable television signal input terminal 202.

[0006]

In the cable modem, a data signal subjected to quadrature phase shift keying (QPSK) from a QPSK transmitter, for example, is input to data terminal 204 as the up signal. The data signal is transmitted through upstream circuit 220 to the CATV station.

[0007]

The down signal input through input terminal 202 is divided into a UHF band (hereinafter also referred to as a B3 band) receiving the frequency of 470 to 860MHz, a VHF-High band (hereinafter also referred to as B2 band) receiving the frequency of 170 to 470MHz and a VHF-Low band (hereinafter also referred to as B1 band) receiving the frequency of 54 to 170MHz, and processed by receiving circuits provided for respective bands. Band ranges are not limited to those specified above.

[0008]

The cable modem tuner 200 further includes a high pass filter 210 having an attenuation range of 5 to 46MHz and a pass band of not lower than 54MHz, and input switching circuits 230 and 235 for allocating the signals passed through the high pass filter 210 to circuits corresponding to respective bands.

[0009]

The down signal is passed through high pass filter 210, the band is switched by the input switching circuits 230 and 235, and supplied to the circuitry corresponding to any of the aforementioned bands B1 to B3.

[0010]

Cable modem tuner 200 further includes high frequency amplification input tuning circuits 240, 242 and 246 provided corresponding to respective bands B1 to B3; high frequency AGC circuits 250 and 255 provided corresponding to the UHF band and VHF band, respectively; high frequency amplification output tuning circuits 260, 262 and 264 provided corresponding to respective bands B1 to B3; a mixer circuit 270 and a local oscillation circuit 280 provided corresponding to the UHF band; a mixer circuit 275 and a local oscillation circuit 285 provided corresponding to the VHF band; and an intermediate frequency amplifying circuit 290 for amplifying, in the intermediate frequency band, outputs from mixer circuits 270 and 275.

[0011]

The high frequency amplification input tuning circuits, the high frequency amplification AGC circuits, the high frequency amplification output tuning circuits, the mixer circuits and the local oscillation circuits provided corresponding to respective bands are adapted such that dependent on the received channel, circuits corresponding to the received band are made operative, while the circuits corresponding to other bands are made inoperative. For example, when a UHF channel is received, the high frequency amplification input tuning circuit 240, the high frequency AGC circuit 250, high frequency amplification output tuning circuit 260, mixer circuit 270 and local oscillation circuit 280 for the UHF band are set to the operative state, while high

frequency amplification input tuning circuits 242 and 244, high frequency AGC circuit 255, high frequency amplification output tuning circuits 262 and 264, mixer circuit 275 and local oscillation circuit 285 for the VHF-High and VHF-Low bands are set to inoperative state, and stop their operation.

[0012]

The CATV signal input to the input terminal 202 is passed through high pass filter 210 as described above, and enters input switching circuits 230 and 235, where band switching takes place. The output therefrom is fed to high frequency amplification input tuning circuit 240, 242 or 246, where channel selection takes place. After channel selection, the signal is amplified to a prescribed level by high frequency AGC circuit 250 or 255 based on the AGC voltage input to AGC terminal 208, and supplied to high frequency output tuning circuit 260, 262 or 264, where the received signal is extracted.

[0013]

Thereafter, the selected received signal is subjected to frequency conversion by mixer circuit 270, 275 and local oscillation circuit 280, 285 to an intermediate frequency (hereinafter also referred to as IF), and amplified by intermediate frequency amplification circuit 290.

[0014]

The intermediate frequency signal (hereinafter referred to as an IF signal) amplified by intermediate frequency amplifying circuit 290 is output from output terminal 295.

[0015]

In this manner, in the conventional cable modem tuner 200, a received CATV signal is selected in accordance with the reception channel, and the signal after channel selection is subjected to frequency conversion and output as an IF signal from output terminal 295.

[0016]

[Problems to be Solved by the Invention]

Handling of a QAM signal, which is a digital signal, and transmitting the IF signal output from output terminal 295 to a QAM demodulating circuit for QAM demodulation by using such a cable modem tuner 200 has the following various problems.

[0017]

(1) First, dependent on the type of QAM demodulating IC used as the QAM demodulating circuit, IF signal of a different frequency band becomes necessary. In the following description, of the IF signals, those output from the conventional cable modem tuner are described as having the frequency band of High-IF, and the frequency range generally not higher than 10MHz and lower than the High-IF will be referred to as Low-IF. At present, QAM demodulating ICs include ICs for receiving Low-IF QAM signals and ICs for receiving High-IF QAM signals. These result from the limitation imposed by the performance of analog/digital converter used in the QAM demodulating ICs. Accordingly, in order to attain a frequency range that can be received by the QAM demodulating IC connected in the succeeding stage, two different types of cable modem tuners have been necessary, or a frequency converting circuit positioned between the cable modem tuner and the QAM demodulating IC has been necessary.

[0018]

(2) The next problem is that the input circuit of QAM demodulation IC is of a parallel type. Conventionally, an IF signal output from a cable modem tuner has been generally a signal of non-parallel type. The QAM demodulation IC, however, generally has parallel type inputs, and therefore, it has been impossible to directly connect the cable modem tuner to the QAM demodulation IC.

[0019]

(3) A further problem is that the IF signal output from the cable modem tuner does not match the input signal level required for the QAM demodulation IC. The conventional cable modem tuner has the gain in the range of 30 to 40 dB, and therefore,

it has been impossible to output the level of about 1Vp-p (which requires the gain in the range of about 60 to 70 dB) generally required as the input signal level of the QAM demodulation IC. The reason for this is that the conventional cable modem tuner is fit for receiving analogue signals and the reception of digital signals was not intended.

[0020]

(4) A further problem is that the input level of the QAM demodulation IC must be constant regardless of variations in the received signals. Though the input level of the QAM demodulation IC must be constant for the received signals, it has been difficult for the conventional cable modem tuner to fully control the signal level of the IF signal output therefrom as regards variations in the CATV signal levels received at the input terminal, as it has only an RF-AGC loop executed by high frequency AGC circuits 250 and 255 shown in Fig. 4.

[0021]

(5) A further problem is that measures to digital noise are necessary. As the QAM demodulation IC requires high input signal level, an amplifier of high gain becomes necessary. Therefore, when the overall system is formed, the clock noise of the provided CPU (Central Processing Unit) and bus noise come to be higher. It is a general practice to mount the QAM demodulation IC, CPU and the cable modem tuner on the same board, and hence, influence of noise would be increased.

[0022]

The present invention was made to solve the above-described problems and its object is to provide a CATV tuner capable of outputting a signal suitable for QAM demodulation.

[0023]

[Means for Solving the Problems]

According to claim 1, the present invention provides a cable modem tuner, including: a tuner portion taking and amplifying a signal corresponding to a reception channel from input signals, and converting to an intermediate frequency signal of a first

frequency band; and a down converter portion receiving the intermediate frequency signal of the first frequency band, and selectively outputting an intermediate frequency signal of the first frequency band or a second frequency band lower than the first frequency band; wherein the down converter portion includes a local oscillation circuit generating an oscillation signal corresponding to the second frequency band in a first mode in which the intermediate frequency signal of the second frequency band is output, and stopping generation of the oscillation signal in a second mode in which the intermediate frequency signal of the first frequency band is output, a mixer circuit for mixing the intermediate frequency signals of the first frequency band input to the down converter portion with an output of the local oscillation circuit, and a filter circuit receiving an output signal from the mixer circuit and passing a signal of a frequency corresponding to a set cut off frequency.

[0024]

The cable modem tuner in accordance with claim 2 corresponds to the cable modem tuner of claim 1, wherein the tuner portion includes a first AGC portion for adjusting amplitude of a signal corresponding to the reception channel to a prescribed level, and the cable modem tuner further includes a second AGC portion arranged between the tuner portion and the down converter portion, for adjusting amplitude of the intermediate frequency signal of the first frequency band to a prescribed level.

[0025]

The cable modem tuner in accordance with claim 3 corresponds to the cable modem tuner of claim 2, wherein total gain attained by the first and second AGC portion is at least 55dB.

[0026]

The cable modem tuner in accordance with claim 4 corresponds to the cable modem tuner of claim 1, wherein the tuner portion and the down converter portion output signals of non-parallel type, and the cable modem tuner further includes a signal converting circuit receiving an output of the down converter portion and converting it to

a parallel type signal.

[0027]

The cable modem tuner according to claim 5 corresponds to the cable modem tuner of claim 1, wherein the mixer circuit amplifies the intermediate frequency signal of the first frequency band in the second mode.

[0028]

The cable modem tuner according to claim 6 corresponds to the cable modem tuner of claim 5, wherein the local oscillation circuit includes an oscillation element oscillating at the second frequency band, a first bipolar transistor receiving at an input electrode an output of the oscillation element, a first bias resistance coupled between the input electrode of the first transistor and a first voltage node, and a second bias resistance connected between one of output electrodes of the first bipolar transistor and the first voltage node; and the mixer circuit includes a second bipolar transistor receiving at an input electrode an output of the oscillation element and the intermediate frequency signal of the first frequency band, a third bias resistance coupled between input electrodes of the first and second bipolar transistors, and a fourth bias resistance coupled between the input electrode of the second bipolar transistor and a second voltage node supplying a voltage higher than the first voltage node.

[0029]

The cable modem tuner according to claim 7 corresponds to the cable modem tuner of claim 6, wherein the local oscillation circuit further includes a switch element of which on/off is instructed externally, connected parallel to the oscillation element, the switch element turning on/off in the first and second modes, respectively.

[0030]

The cable modem tuner according to claim 8 corresponds to the cable modem tuner of claim 6, wherein the filter circuit and the second bias resistance are mounted on one surface of a printed board, and the down converter portion except for the second bias resistance is mounted on the other surface of the printed board.

[0031]

The cable modem tuner according to claim 9 corresponds to the cable modem tuner of claim 1, wherein the cut off frequency is set such that the signal of the second frequency band is passed and the signal of the first frequency band is attenuated in the first mode, and that the signals of the first and second frequency bands are passed in the second mode.

[0032]

The cable modem tuner according to claim 10 corresponds to the cable modem tuner of claim 9, wherein the filter circuit has an inductance element passing an output signal of the mixer circuit, a first capacitance element coupled between the induction element and the ground node, a second capacitance element coupled in parallel with the induction element, and a switch element provided parallel to the second capacitance element and of which on/off is instructed externally, the switch element being turned off/on in the first and second modes, respectively.

[0033]

The cable modem tuner according to claim 11 corresponds to the cable modem tuner of claim 1, further including: an intermediate frequency AGC portion positioned between the tuner portion and the down converter portion adjusting amplitude of the intermediate frequency signal of the first frequency band to a prescribed range; and a signal converting circuit receiving an output of the down converter portion and converting to a parallel type signal; wherein the cut off frequency is set such that the signal of the second frequency band is passed and the signal of the first frequency band is attenuated in the first mode, and that the signals of the first and second frequency bands are passed in the second mode.

[0034]

The cable modem tuner according to claim 12 corresponds to the cable modem tuner of claim 11, wherein the tuner portion, the intermediate frequency AGC portion, the down converter portion and the signal converting circuit are contained in one box.

[0035]

[Embodiments of the Invention]

In the following, embodiments of the present invention will be described in detail with reference to the figures.

[0036]

Fig. 1 is a block diagram representing a configuration of cable modem tuner 100 in accordance with an embodiment of the present invention.

[0037]

Referring to Fig. 1, the cable modem tuner 100 in accordance with the present invention differs from the conventional cable modem tuner 200 shown in Fig. 4 in that it includes a group of circuits 10 to 80 receiving an IF input signal of High-IF output from intermediate frequency amplifying circuit 290 and converting the received signal to an IF output signals suitable for QAM demodulation that is set to either the High-IF or Low-IF frequency band selectively. The IF output signal is applied from output terminal 80 to QAM demodulating circuit.

[0038]

Thereafter, blocks up to generation of the IF input signal, that is, components contained in the conventional cable modem tuner 200 are the same as those described above, and therefore, description thereof is not repeated.

[0039]

Cable modem tuner 100 includes: an SAW filter 10 receiving an IF input signal; an intermediate frequency AGC circuit 20 (hereinafter also referred to as an IF-AGC circuit); a down converter portion 30 capable of selectively outputting a Low-IF signal and a High-IF signal; and a parallel/non-parallel converting circuit 70 for converting a non-parallel signal output from down converter portion 30 to a parallel signal. Down converter portion 30 includes: a local oscillation circuit 50 for generating an oscillation signal of a frequency range corresponding to Low-IF; a mixer circuit 40 for mixing the output signal of IF-AGC circuit 20 with the oscillation signal; and a filter circuit 60

capable of switching the cut-off frequency when the Low-IF signal is output and when High-IF signal is output.

[0040]

The IF input signal corresponding to the reception channel selected by the tuner is passed through the SAW filter 10, has its amplitude adjusted to a prescribed level by IF-AGC circuit 20, and thereafter fed to the mixer circuit 40.

[0041]

As will be described in detail later, down converter portion 30 is capable of selectively outputting either the High-IF signal or the Low-IF signal, in accordance with an external switching instruction.

[0042]

When output of Low-IF signal is instructed externally (hereinafter also referred to as Low-IF signal output mode), an oscillation signal corresponding to the Low-IF signal is output by the local oscillation circuit 50. Mixer circuit 40 mixes an output from IF-AGC circuit 20 with the oscillation signal, and provides the Low-IF signal. Filter circuit 60 sets the cut off frequency such that the signal of the Low-IF band is passed, in response to the external switch instruction. As a result, down converter portion 30 down-converts the IF input signal to the Low-IF band, and outputs the result to parallel/non-parallel converting circuit 70.

[0043]

When the output of the High-IF signal is instructed externally (hereinafter also referred to as High-IF signal output mode), it is unnecessary for the down converting portion 30 to perform frequency conversion, and what is necessary is simply to output the signal having the same frequency as the IF input signal. Therefore, in this case, oscillation of the local oscillation circuit 50 is stopped, and mixer circuit 40 operates as an intermediate frequency amplifying circuit. Here, filter circuit 60 sets the cut off frequency such that the signal of the High-IF band is passed, in response to the external instruction. As a result, down converter portion 30 outputs the High-IF signal output

to parallel/non-parallel converting circuit 70.

[0044]

Fig. 2 is a circuit diagram representing a specific configuration of the down converter portion 30.

[0045]

Referring to Fig. 2, SAW filter 10 has a function of converting the IF input signal received from intermediate frequency amplifying circuit 290 to a bandwidth to be transmitted, and of removing unnecessary signals. The SAW filter is for extracting voltage oscillation caused by surface acoustic wave, by an electrode provided on a surface of a piezoelectric element, and characterized in that resonance characteristic is variable dependent on the position and structure of the electrode.

[0046]

IF-AGC circuit 20 includes a dual gate type field effect transistor T1, receiving an output signal from SAW filter 10 and an AGC voltage input to AGC terminal 72. Transistor T1 is provided for amplifying the output signal from SAW filter 10 in accordance with the AGC voltage. Between the AGC terminal 72 and one of the dual gates, resistance element R3 is connected, and corresponding to the AGC terminal 72 and one of the dual gates, ground capacitors C7 and C2 are connected, respectively.

[0047]

Between the SAW filter 10 and the other one of the dual gates, a resistance element R1 and a capacitor C1 for preventing DC component to transistor T1 are provided, and a gate bias resistance R2 is connected between the other one of the dual gates and the power supply terminal 74. An inductor L1 corresponds to a choke coil.

[0048]

The AGC voltage is set by the AGC control circuit (not shown) to secure the level 1Vp-p of the output IF signal applied from the output terminal 80 to the QAM demodulating circuit. The gain attenuation amount of IF-AGC by the IF-AGC circuit 20 having such a structure is about 50dB. Therefore, by the combination with the RF-

AGC implemented by high frequency AGC circuits 250 and 255, it is possible to ensure a level of 1V_{p-p} of the output IF signal.

[0049]

Mixer circuit 40 and local oscillation circuit 50 include bipolar transistors T2 and T3, respectively. Resistance elements R4, R5 and R8 provided as base bias for bipolar transistors T2 and T3 are connected in series. Therefore, cost advantageously, the number of components can be reduced.

[0050]

By setting the collector-emitter voltage V_{CE} of bipolar transistor T2 in mixer circuit 40 to 2.5V, and by setting V_{CE} of bipolar transistor T3 in local oscillation circuit 50 to about 1.5V, it is possible to reduce power consumption.

[0051]

Local oscillation circuit 50 further includes a quartz oscillator 55. Both the over tone type and fundamental wave type oscillators can be applied as the quartz oscillator 55. A capacitor C16 provided between the emitter of bipolar transistor T and the base of bipolar transistor T2 is a capacitance element for supplying the oscillation signal to the mixer. When bipolar transistors T2 and T3 are realized as twin type elements, it is possible to implement capacitor C16 by the parasitic resistance in the mold. This further reduces the number of components.

[0052]

Local oscillation circuit 50 further has a switch SW1 provided parallel to the quartz oscillator 55. By turning on the switch SW1 in response to an external switch instruction, the output node of quartz oscillator 55 can be forced to be connected to the ground node, attaining the same effect as stopping oscillation.

[0053]

Capacitors C4, C5 and C6 positioned in mixer circuit 40 and local oscillation circuit 50 are ground capacitances, while capacitors C8 and C10 are feed back capacitances. Capacitors C3, C9 and C11 are provided for preventing the DC

component of the signal. The resistance elements R6, R7 and R10 are bias resistances provided corresponding to bipolar transistors T2 and T3, and resistance element R9 is a dumping resistance for adjusting oscillation frequency of quartz oscillator 55.

[0054]

Filter circuit 60 is formed, as an example, by a low pass filter in Fig. 2, and has an inductor L2 passing an output from mixer circuit 40, a capacitor C13 connected parallel to inductor L2, a switch SW2 connected parallel to the inductor L2 and capacitor C13, and capacitors C12 and C14 connected between the inductor L2 and the ground node.

[0055]

Cut off frequency of the filter circuit 60 can be switched by turning on/off the switch SW2 in accordance with an external switch instruction. More specifically, in the High-IF signal output mode and the Low-IF signal output mode, SW2 is turned on and off, respectively.

[0056]

When switch SW2 is off, filter circuit 60 passes the Low-IF signal and attenuates the High-IF signal. Therefore, the values of capacitors C12, C13 and C14 and of inductor L2 are determined such that the cut off frequency is lower than the High-IF band and higher than the Low-IF band.

[0057]

When the switch SW2 is on, both ends of inductor L2 and capacitor C13 are short-circuited. Therefore, the cut off frequency goes high, and filter circuit 60 passes the High-IF signal as well. At this time, the value of capacitor C14 is set such that the cut off frequency at this time becomes higher than the High-IF band.

[0058]

In this manner, by providing a filter circuit 60 of which cut off frequency can be switched in accordance with an external instruction, it becomes possible to operate the filter circuit as an intermediate frequency tuning circuit.

[0059]

Further, as filter circuit 60 is connected as a load to mixer circuit 40, the effect of minimizing leakage of the local oscillation circuit 50 is also attained.

[0060]

The output of filter circuit 60 is transmitted to parallel/non-parallel converting circuit 70. Parallel/non-parallel converting circuit 70 converts the output of filter circuit 60 to 2-output signals different in phase by 90°, and provides as parallel outputs, to output terminal 80. As the output of cable modem tuner 100 is turned to the parallel signals by parallel/non-parallel converting circuit, it becomes possible to directly connect the cable modem tuner 100 to the QAM demodulating IC provided in the succeeding stage.

[0061]

If it has a configuration that has the same function and is capable of passing the signals of the frequency ranges in the High-IF signal output mode and the Low-IF signal output mode, any structure may be used for filter circuit 60, other than the example shown in Fig. 3. The same applies to the configurations of IF-AGC circuit 20, mixer circuit 40 and local oscillation circuit 50.

[0062]

Switches SW1 and SW2 provided for local oscillation circuit 50 and filter circuit 60 are turned on in the High-IF signal output mode, and turned off in the Low-IF signal output mode. Switches SW1 and SW2 are commonly controlled in accordance with an external instruction. Electronic switches and mechanical switches may be used as switches SW1 and SW2.

[0063]

When switches SW1 and SW2 are turned on, oscillation of quartz oscillator 55 is stopped, and the cut off frequency of filter circuit 60 becomes higher. Therefore, mixer circuit 40 amplifies the IF input signal without changing the frequency thereof, and filter circuit 60 passes the High-IF signal.

[0064]

When switches SW1 and SW2 are off, the oscillation output of the Low-IF band of quartz oscillator 50 is amplified by local oscillation circuit 50 and transmitted to mixer circuit 40. Mixer circuit 40 mixes the oscillation signal received from local oscillation circuit 50 with the output signal of IF-AGC circuit 20, and provides a signal in the Low-IF signal band. The capacitance value of capacitor C13 in filter circuit 60 is set such that the signal in the Low-IF signal band is passed while the signal in the High-IF signal band is attenuated, when switch SW2 is off.

[0065]

Because of this structure, down converter portion 30 including mixer circuit 40, local oscillation circuit 50 and filter circuit 60 outputs the signal in the High-IF band when switches SW1 and SW2 are on, and outputs a signal in the Low-IF band when switches SW1 and SW2 are off. More specifically, it becomes possible by a single down converter portion 30 to selectively output IF signals of different frequency bands, by turning on/off the switches. Thus, it can be commonly used for QAM demodulating ICs having inputs of different frequency bands.

[0066]

Here, when the circuitry including mixer circuit 40 and local oscillation circuit 50 except for the bias resistance R10 are arranged on one surface of a printed board, and filter circuit 60 and bias resistance R10 are arranged on the other surface of the printed board, a circuit configuration is attained in which output of the High-IF signal can be realized simply by the circuits mounted on the other surface of the printed board, and by adding the circuit configuration on one surface of the printed board, the circuit configuration is realized in which both Low-IF and High-IF signals can selectively be generated.

[0067]

As the switching function by switches SW1 and SW2 is provided, it is possible to mount the circuitry shown in Fig. 2 on one surface of the printed board.

[0068]

Fig. 3 is a block diagram showing the overall QAM demodulating system 300 in accordance with one embodiment of the present invention.

[0069]

Referring to Fig. 3, QAM demodulating system 300 includes an input terminal 301 receiving the CATV signal, circuits 310 including the conventional cable modem tuner 200 and the circuits provided in the succeeding stage thereof, and a QAM demodulating IC 320. The conventional cable modem tuner 200 and the circuits 310 constitute the cable modem tuner 100 of the embodiment shown in Fig. 1, and provides the IF signal corresponding to the reception channel, to QAM demodulating IC 320. As already described, the IF signal output from cable modem tuner 100 can be set to either of the High-Low IF frequency bands, and the signal is a parallel type signal having the signal level of 1Vp-p. Namely, the signal is suitable as an input signal to the QAM demodulating IC 320.

[0070]

As the output of cable modem tuner 100 and the input to QAM demodulating IC 320 are both parallel type, an additional effect of suppressing external digital noise at the connecting portion therebetween is also attained.

[0071]

As the AGC voltage set in accordance with the input signal level to QAM demodulating IC 320 is supplied to the IF-AGC circuit 42 and the high frequency AGC circuit in tuner 200, RF-AGC and IF-AGC loops are formed.

[0072]

QAM demodulating system 300 further includes a processing unit (CPU) 330 for controlling the overall system, and a system bus 340 for transmitting signals within the system. CPU 330 controls, through system bus 340, the operation of selection by cable modem tuner 100, demodulating process by QAM demodulating IC 320 and the like. When switches SW1 and SW2 contained in the down converter unit are

electronic switches, switch instruction of these switches is also given by the CPU 330.

[0073]

In QAM demodulating system 300, the cable modem tuner 100 consisting of the conventional cable modem tuner 200 and the circuits 310 is contained in one box SC and shielded from the outside. Therefore, influence of external noise caused by the system bus CPU clock and the like on the cable modem tuner 100 can be suppressed.

[0074]

The embodiments as have been described here are mere examples and should not be interpreted as restrictive. The scope of the present invention is determined by each of the claims with appropriate consideration of the written description of the embodiments and embraces modifications within the meaning of, and equivalent to, the languages in the claims.

[0075]

[Effects of the Invention]

The cable modem tuner in accordance with the present invention includes a down converter portion that mixes an output of a local oscillator circuit, of which generation of an oscillation signal in a frequency band lower than the frequency band of the intermediate frequency signal output from the tuner portion can be executed/stopped in a switching manner, and an intermediate frequency signal of the frequency band output from the tuner portion, it becomes possible to selectively output intermediate frequency signals of different frequency bands by a circuit of one same configuration. As a result, it becomes possible to generally apply the cable modem tuner of the present invention to QAM demodulation circuits of different input frequency ranges. Further, as a filter circuit is connected to the output load of the mixer circuit, leakage of the local oscillation circuit can be suppressed.

[0076]

Further, in addition to the AGC unit of high frequency range included in the tuner portion, the AGC unit for intermediate frequency signal is provided, and therefore,

variation of output signal related to the variation of the input reception signal level can be suppressed. As a result, a signal suitable as an input signal to the QAM demodulation circuit can be output.

[0077]

Further, as the total gain of the AGC portion is ensured to be at least 55 dB, it becomes possible to attain 1Vp-p required as the input signal level of the QAM demodulation circuit.

[0078]

Further, as a signal converting circuit for converting a non-parallel signal to a parallel signal is provided, a signal suitable as an input signal to the QAM demodulation circuit can be output.

[0079]

Further, by forming the local oscillation circuit and the mixer circuit by bipolar transistors and connecting base bias resistances provided for respective bipolar transistors in series to each other, the cost can be reduced.

[0080]

Further, by mounting a circuit that operates when an intermediate frequency signal of the frequency band output from the tuner portion is output and a circuit that operates when an intermediate frequency signal of a frequency band lower than the intermediate frequency signal mentioned above is output on different surfaces of a printed board, the frequency range of output signals can more efficiently be switched.

[0081]

Further, by switching the cut-off frequency of the filter circuit, it become possible to additionally provide the function as an intermediate frequency tuning circuit.

[0082]

Further, as the AGC unit for the intermediate frequency signal and the signal converting circuit receiving a non-parallel output signal to a parallel signal are provided, it becomes possible to generate an output signal that can be directly input to the QAM

demodulating circuit and to form an efficient QAM demodulation system.

[0083]

Further, as the tuner portion, the intermediate frequency AGC unit, the down converter portion and the signal converting circuit are contained in one same box, influence of external noise can be reduced.

[Brief Description of the Drawings]

Fig. 1 is a block diagram representing a configuration of cable modem tuner 100 in accordance with an embodiment of the present invention.

Fig. 2 is a circuit diagram illustrating a specific configuration of down converter portion 30.

Fig. 3 is a block diagram showing an overall system of QAM demodulation system 300 in accordance with an embodiment of the present invention.

Fig. 4 is a schematic block diagram of a conventional cable modem tuner 200.

[Description of the Reference Characters]

10 SAW filter, 20 intermediate frequency AGC (IF-AGC) circuit, 30 down converter portion, 40 mixer circuit, 50 local oscillator circuit, 60 filter circuit, 70 parallel/non-parallel converting circuit, 320 QAM demodulation circuit, 330 CPU, 340 system bus.

【書類名】

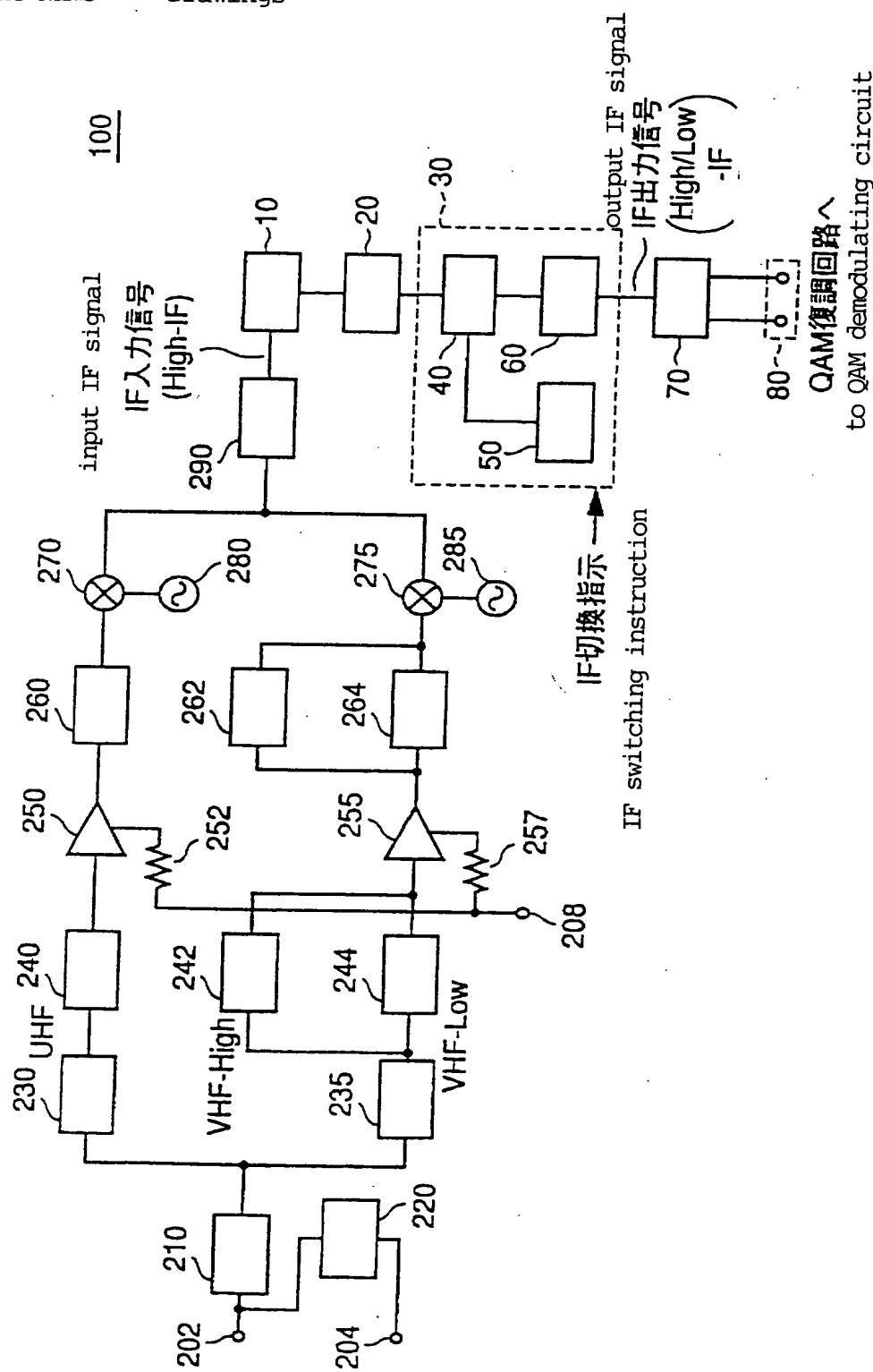
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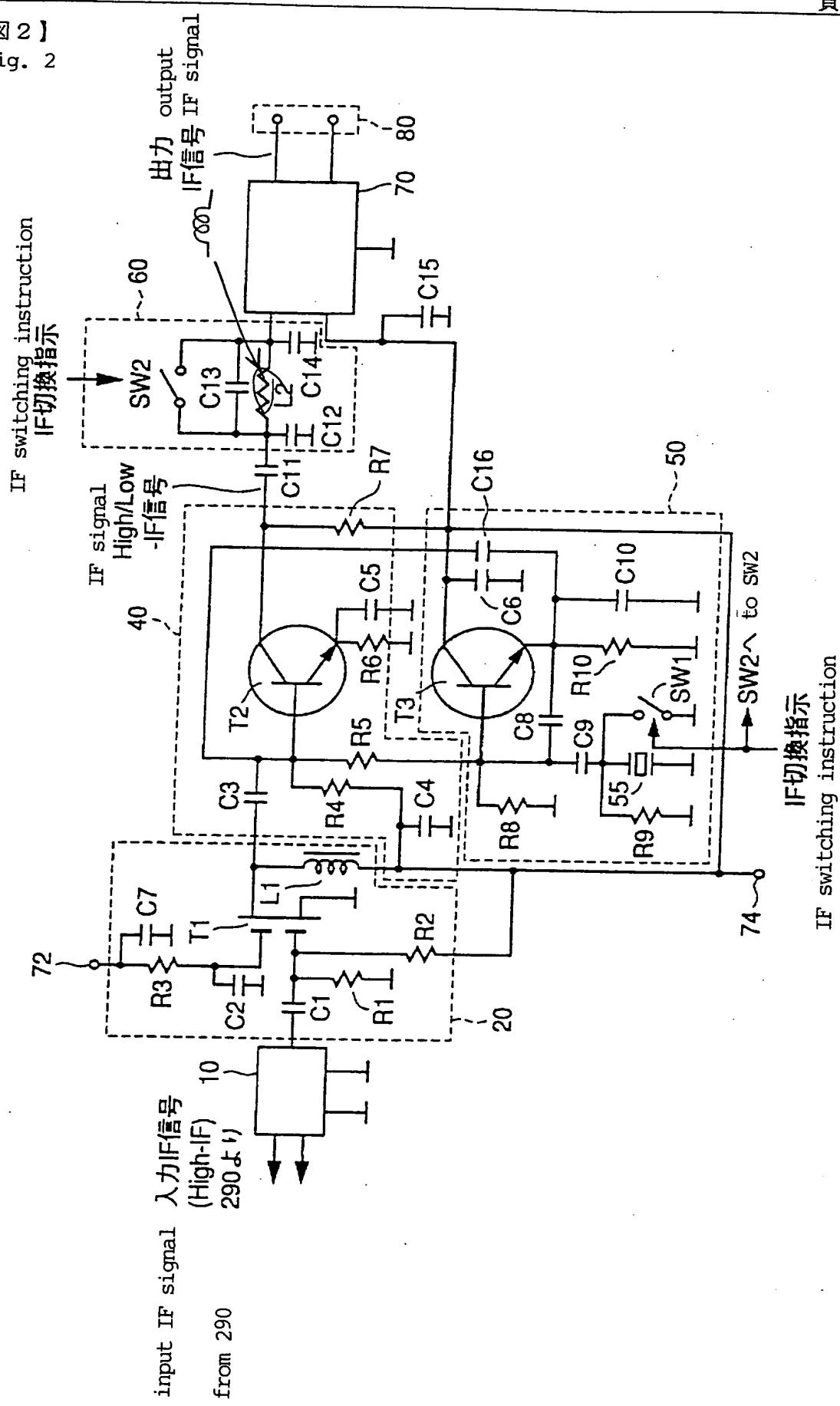
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Drawings

【図1】

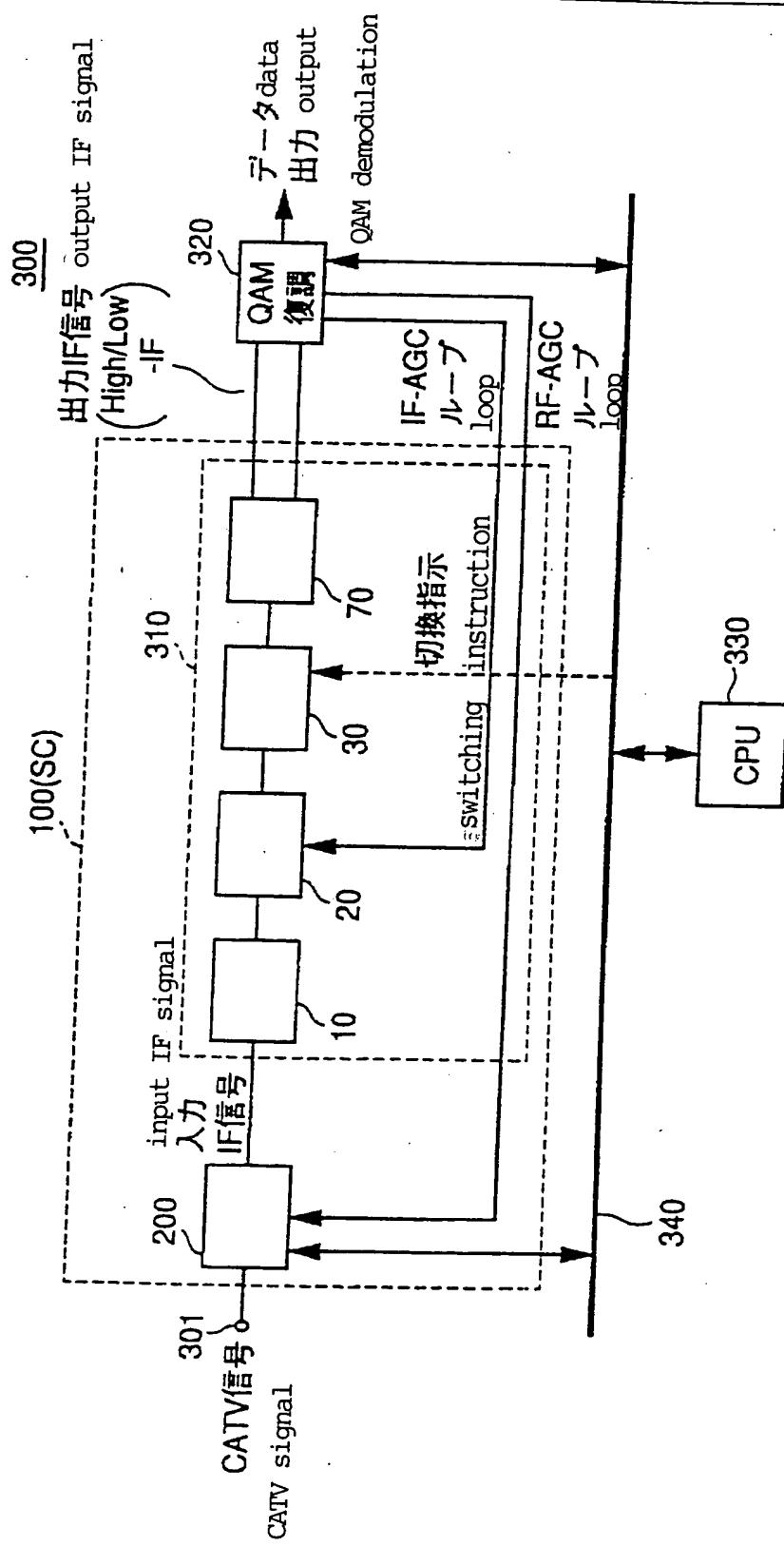
Fig. 1



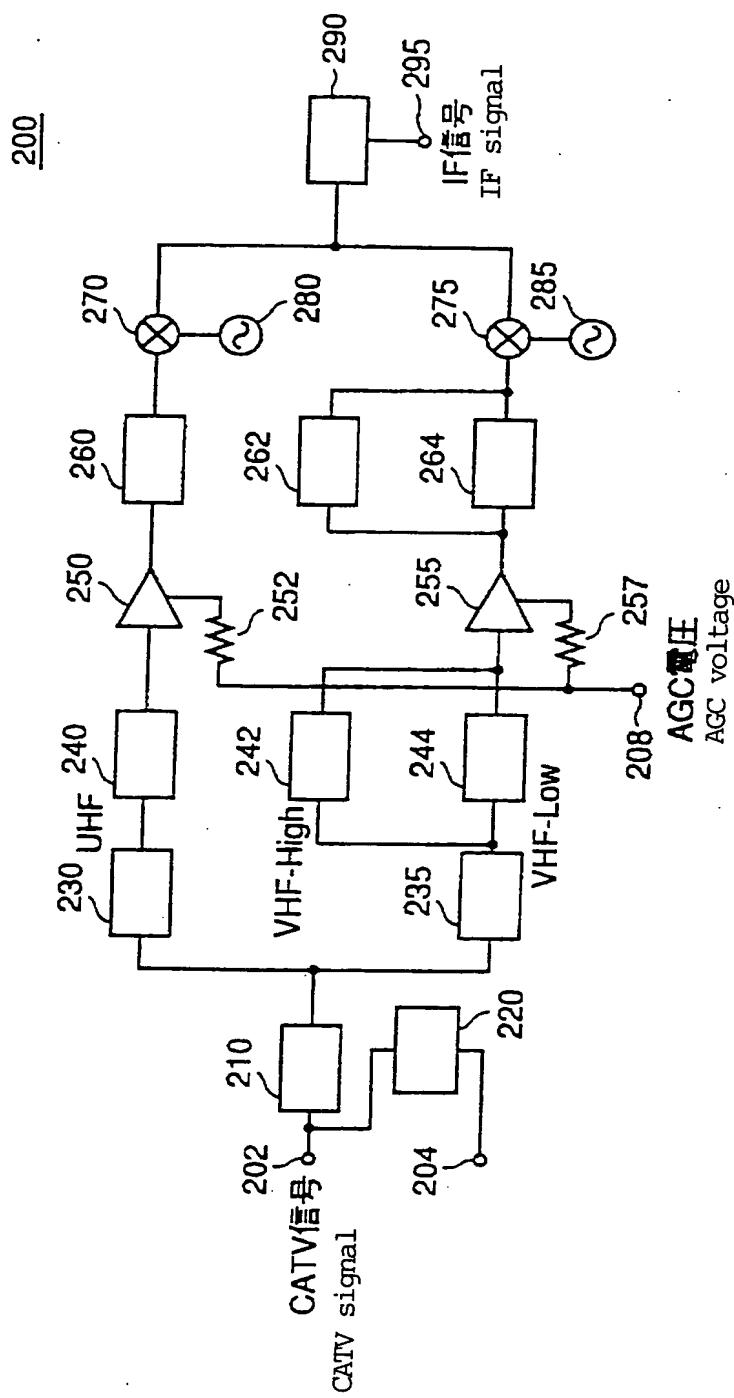
【図 2】
Fig. 2

【図3】

Fig. 3



【図4】
Fig. 4



[Document Name] Abstract

[Abstract]

[Subject] An object is to provide a cable modem tuner capable of outputting a signal suitable for QAM demodulation.

[Solving Means] An IF input signal corresponding to a selected reception channel is passed through an SAW filter 10, has its amplitude adjusted to a prescribed level by an IF-AGC circuit 20, and then supplied to a down converter portion 30. In response to an external instruction, down converter portion 30 selectively outputs a Low-IF signal obtained by down-converting the IF input signal and a High-IF signal obtained by amplifying the IF input signal without frequency conversion. A filter circuit 60 is a low pass filter, of which cut-off frequency is selectively set such that only the Low-IF signal or both the Low-IF signal and High-IF signal can be passed.

[Selected Drawing] Fig. 1